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ABSTRACT

Many studies and much "common knowledge" in the United States today decry the quality of the work force and the "basic literacy needs" of today's and tomorrow's workers. Widespread concern exists that U.S. workers are ill-equipped to compete in the global marketplace and that schools and vocational programs are failing to keep pace with changing skills requirements. Comments about "skills deficits" and lack of workforce preparedness have increased as the number of women, minorities and immigrants entering the workforce have increase. A 3-year observational study, however, found different realities. The study involved two contract manufacturers of circuit board assemblies, the fastest growing and one of the most competitive branches of the electronics industry. The purpose of the study was to: (1) identify in ethnographic detail the literacy-related skills that are required in changing workplaces; (2) to compare the literacy requirement of "high performance" workplaces with those of more traditionally organized ones; and (3) to construct innovative ways to introduce educators to the changing skill demands of work. According to extensive observations at two factories, including one that is especially high tech and team based, literacy skills should be measured in context and not merely as a set of competencies. Workers in the high-tech, team-based electronics factory used complex and intertwined skills of reasoning, mathematics, inferencing, and negotiation to determine relationships and solve problems. Although these workers came from a variety of ethnic backgrounds and possessed varying degrees of English skills, they were able to solve problems as a team and meet very high quality and production standards. For the most part, the workers contributed very high-level thinking skills for very low pay. A consideration for educators is that high-tech, multiethnic workplaces do not call for a static set of "basic" skills, rather for ways of negotiating, finding common ground, and respecting the experiences and perspectives of fellow workers. (Contains 12 references.) (KC)

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Literacies in a Changing Workplace:
A Look at the Uses of Literacy
in a Multi-ethnic, High-tech Electronics Factory

Not long ago, while browsing through messages on the National Workforce Assistance Collaborative list, one of many on-line discussions of education and work, we ran across the following lament from the owner of a small management consulting firm:

> My clients have employees that can't read, write, reason, and complete the most basic math functions... School systems have not and are not doing their jobs. It is as simple as that. The young people today are not prepared for the challenges of today let alone tomorrow. We are in serious trouble in this country. We are losing our manufacturing base and it will only get worse.

Such concerns certainly are not new. (In fact, a chorus of similar complaints kicks in each year around school levy time, or election time, or campaign time, or dinner time with people who have just discovered you're a public school teacher.) They echo a decade -- some would say a century -- of reports by government commissions on the skills of the current and future workforce. In particular, as the number of women, people of color and immigrants entering the workforce has increased, so have comments about "skills deficits" and a lack of worforce preparedness. However, we would like to offer an alternative view which has grown out of nearly three years of observations in two large, high-tech, multicultural workplaces undergoing orgnaizational change. We want to present a close look at some of the literate practices in these workplaces, hoping to challenge popular assumptions about workers and about the skills they are said to need. Perhaps this in turn might challenge parallel assumptions about the changing populations in American schools.

Background of the Study

Our research—an ethnographic study of literacy practices within a manufacturing plant undergoing organizational change—began in the context of this widespread concern that US workers are ill-equipped to compete in the global marketplace and that schools and vocational programs were failing to keep apace of changing skills requirements (see Hull, 1993 for a review of these arguments and also *The Bottom Line*, 1988; Carnevale, Gainer, & Metzer, 1988; Lund &

McGuire, 1990). The claim was that, in order to be competitive, American industries had to adopt new technologies and new forms of work organization often labeled "high performance," in contrast to more traditional, Tayloristic models (*America's Choice,* 1990; SCANS, 1992; for a recent review see Applebaum & Batt, 1993). In turn, schools were urged to teach the knowledge and skills thought to be needed in restructured, technologically sophisticated workplaces (cf. Marshall & Tucker, 1992).

Since we began our project, worries about declining skills have, if anything, escalated, and the rush is definitely on to develop programs and curricula which can move students more successfully from the schoolhouse to the workplace—consider the plethora of school-to-work initiatives, including Tech-Prep programs, Career Academies, career majors, youth apprenticeships, integrated academic-vocational curricula, curricular links to industry skills standards or to SCANS competencies or both, total quality learning, and the list goes on. At the same time that we see increased concern about what workers need to know, admonitions for companies to restructure, to try out new practices—teams, continuous improvement, total quality management, training, cross-training, wage compression, symbolic egalitarianism, the list goes on and on—have become a familiar refrain in the media and the boardroom and in schools of business and management (cf. Pfeffer, 1994; Smith, 1995).

For the past three years we have carried out an ethnographic study of two contract manufacturers of circuit board assemblies, the fastest growing and one of the most competitive branches of the electronics industry[1]. Our purpose has been (1) to identify in ethnographic detail the literacy-related skills that are required in today's changing workplaces; (2) to compare the literacy requirements of "high performance" workplaces with those of more traditionally organized ones; and (3) to construct innovative ways to introduce educators to the changing skill demands of work[2].

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[1] This project is directed by Glynda Hull of the University of California, Berkeley, and is co-sponsored by the National Center for the Study of Writing and Literacy and the National Center for Research in Vocational Education. Others who have worked on the project include Meg Gebhard, Pablo Jasis, Brian Reilly, Mary Schmida, Kathy Schultz, Pam Stello, Craig Wilson, and Oren Ziv.

[2] With regard to this latter purpose, we are developing an interactive multimedia database in which we present data from our field research in the form of texts and documents, photographs, audio, and video. In so doing, we aim to

Many large companies have adopted some of the trappings of "high performance," and thus they will readily report their use of self-directed work teams or their practice of continuous improvement. But frequently companies adopt high performance practices piecemeal, leaving the organization of the workplace and the daily lives of workers unaffected to a great extent. We have studied one such company, which we call EMCO, and have found that it resembles what most people would consider a traditionally organized workplace. While EMCO touted a team approach to work, the teams are comprised of supervisors, engineers, administrators and managers. The company offers no forum or structured opportunity for production workers to give input on how work gets done[3]. The rarity, however, is the company which genuinely attempts to rethink itself, to change its workplace culture, to reorganize in ways that affect all employees' work practices and skill requirements. We have been lucky to identify one such company, and there we are noticing significant differences in the literacy requirements and practices between this "high performance" factory and the more traditionally organized one.

We call this particular circuit board assembly manufacturer "Teamco," to highlight its move toward implementing self-directed work teams and other characteristics of "high performance" work organization. Teamco, headquartered in California's Silicon Valley and with plants worldwide, is a Fortune 500 company with annual revenues in excess of $1 billion. The 12 plants that make up its Silicon Valley campus employ approximately 5,000 people, including over 550 in the building where we have based most of our site visits. This workplace is quite multicultural—Chinese, Vietnamese, and Filipino are its dominant groups, although many other ethnicities are present. Employees on the manufacturing floor, production workers, range in age from 18 to over 60; some have completed a bit of elementary school, others have advanced degrees. The plant

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introduce educators to the complex contextual circumstances in which workers engage in literate behavior within the factories we have studied, and to help them discover how literacy occurs and obtains its significance through events within the workplace and how literacy and its requisite skills are inexorably linked with a social-cultural-historical context. The multimedia format is particularly important for this project on the workplace, since high-tech factories and the literacy-related work that takes place in them aren't easily visualized.

[3] We are using the term "production worker" here to refer to those employees on the manufacturing floor with positions anywhere in the hierarchy beneath a supervisor. This includes entry-level workers (e.g., mechanical assembly, handload and set-up) and those workers whose positions require various levels of training and further certification (hand-solderers, machine operators and test technicians).

accepts entry-level employees, although most workers have experience in other Silicon Valley companies, and there are some opportunities for advancement within the firm. Teamco is non-union (as are virtually all electronics firms in the Silicon Valley), and it represents "high end" manufacturing, focusing on high quality and the full range of services. The company, which has won state, national and industry awards for quality, carries out design, assembly, quality checks, testing, and packaging of circuit boards for diverse products, from calculators and computers to avionics and medical equipment.

While it has been our observation that more traditionally organized workplaces (such as EMCO) may also utilize literacy in a broad variety of forms, at Teamco, we have been interested in understanding how this company's shift toward a high performance workplace is changing the kinds and uses of literacy, numeracy and oral communication skills that production workers need to function successfully. We observed a tendency among managers and supervisors at Teamco to make assumptions about workers' skills and knowledge, and to underestimate their understanding of literate practices upon which the factory was coming increasingly to depend. What we have seen of work practices and the role of texts within them has caused us to rethink our notions of literacy and the skills commonly associated with it. Furthermore, our observations highlight the indispensability of analyzing such skills in relation to the contexts in which they occur, rather than analyzing them as autonomous tasks -- as ends in and of themselves. Work is never simply a set of tasks but, as Raymond Williams (1968) has noted, is a set of social relationships from which the tasks cannot be disentangled.

This in turn raises some questions about schooling, skills, and knowledge, about who has what abilities and where and how those abilities are developed. This research calls into question what we would describe as 'a building-block concept of literacy skills acquisition' and emphasizes the need to discuss language practices, in schools as well as in the workplace, in context. We would suggest that skills need to be developed within and grow out of meaningful contexts. Although it is important to develop critical literacy and numeracy, we feel it is equally important to

develop an understanding of how the social networks within which literate and numerate practices are embedded help to foster or inhibit the development of particular skills.

In the next two sections we offer brief and partial views of two events: first, the opening activities of a self-directed work team (SDWT) meeting; then, an overview of a goal review process, beginning with a worker's presentation to a review board. We offer these two events as opportunities to facilitate thinking about the relationship between the literate practices in this factory and the way work is organized.

A Self-Directed Work Team Meeting

On a Wednesday afternoon in mid-April at 3 PM, which marks the end of day shift, a group of 23 workers clad in white, knee-length company jackets, all members of Team 21, convene in a cramped conference area out on the factory floor. The meeting room consists of several five foot high, moveable cubicle walls which enclose an oblong conference table big enough to seat 10-12 workers comfortably. This team, however, the Final Mechanical/Final Quality Assurance (QA) team, is large enough to necessitate a ring of standing workers who encircle those seated around the table. As team members arrive each one picks up a copy of the meeting minutes and agenda stacked neatly in a pile at the end of the table nearest the entry. While they wait for the meeting to begin, they quietly peruse the two-page document. Rachel Solarzano, the Team 21 supervisor, sits with pen in hand, making notes -- reminders to herself about important issues that need to be taken up with the group. An employee of European American descent in her mid-thirties, Rachel has worked at Teamco for just over two years. While she is deeply committed to the company she is also devoted to those whose work she oversees. Rachel acknowledges the stress associated with the Continuous Flow Manufacturing (CFM) process, and she makes a point of praising employees' hard work frequently during team meetings, promising that team members will reap the benefits of their labor when bonuses are distributed.

As the room becomes increasingly full, Rachel allocates space to individuals, asking those on the sides to move back in order to make room for everyone. When all members of the team are

present, Rachel asks QA lead[4] April Nguyen, a petite and rather shy Vietnamese woman with graying hair, to read the minutes from the previous week and the agenda for the current meeting. As April reads aloud to the group, team members follow along with her on the copies they hold in their hands. A review of the minutes and agenda is followed by a request from Rachel for reports from three members of the Final Mechanical/Final QA area (which includes five production lines in all) on problems in their respective areas that they feel are worthy of the team's attention.

In a variety of English heavily influenced by his Japanese roots, Toshio Kogawa animatedly describes difficulties with boards coming from another line -- Second Handload. Toshio and his co-workers are getting boards with a tilted component, which is problematic because it conflicts with the MPI (Manufacturing Process Instructions), a complex written document, sometimes as many as 20 pages long. In this particular case the MPI indicates that the component must be soldered flush with the board. Toshio tells Rachel that the boards often arrive at Final Mechanical in a state that doesn't comply with protocol -- a situation which warrants finding a way to solve this ongoing problem. The following excerpt of Rachel and Toshio's conversation is typical in terms of the manner in which problems are presented in the context of Team 21 meetings, and provides a sense of the kinds of exchanges that occur between this team supervisor and the line workers. The turns are often latched and overlapped, which reflects the relaxed feel of the meetings and the exchange also gives some indication of the significant kinds of language learning opportunities that occur regularly in the Teamco work context.

Toshio: E:h we got problem on uh 606[5]? Eh? So Second Handload they got push their ICs up. They're connected here [motioning with his hands]. The xxx push by the middle <2> push down the part.

Rachel: Okay so what you're saying is =the ICs=
Toshio: =xx this way. Yeah=
Rachel: are tilted?==

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[4] In this company a "lead" is a worker with increased responsibility and no increase in pay. In pre-team times, the company paid leads an extra 10 percent for their added responsibilities. But with teams came the notion that a lead in the production area runs counter to the team concept, that all team members are "leads," so the official title was removed and the 10 percent pay differential dropped. Nevertheless, the leads still function in the same capacity—and they are still referred to as leads by production workers, supervisors, engineers, and managers.

[5] The number "606" refers to the board type, as does Toshio's reference to "653" at the end of the exchange.

Toshio: ==Yeah. Still high.==
Rachel: ==So the leads weren't flush =into the board?=
Toshio: =yeah= the two side xxxxx. /Rachel: Okay/ The xx
Rachel: Socket
Toshio: Socket. Yeah. That's a problem.
Rachel: They were sticking out of the socket /Toshio: Yeah/ On one side, right?==
Toshio: ==Yeah. And the other one is uh 653? The CPU the locking system? /Rachel: um hm/ sometimes xxx. Looks like it just sometimes not very x not very hard==
Rachel: ==So they're not locking it correctly?==
Toshio: ==No locking correctly, but uh CPUs uh still one side high one side down.
Rachel: OK.
Toshio: Different. That's a problem.
Rachel: So those are the two major things that you found, =right?=
Toshio: =yeah.=

Through Rachel and Toshio's lively exchange, peppered with hand gestures which mimic the physical relationship of the component to the board, the two come to a clear verbal understanding of what the problem is. Rachel thanks Toshio for bringing it to her attention and she promises to look into it.

Following Toshio's report Binh Tran a young, soft-spoken Vietnamese worker on the Final Mechancial line, steps forward to give an account of difficulties in his area. As he does so, he reaches into his pocket and pulls out a piece of paper from which he reads for the duration of his presentation to the team. The group listens attentively while Binh lists the difficulties he is aware of, and minutes taker Carlotta Bonilla, a Filipina in her early twenties who works in the QA area, takes notes assiduously. When Binh has finished, several members of the group lightly applaud his thorough account for which Rachel thanks him. Jorge Garcia, a middle-aged Mexican-American worker from Final Mechanical, also reports on problems. He informs the team that his line is getting boards with loose nuts or without nuts and washers at all. Rachel queries him, wondering if either he or the lead for his area is communicating about this issue with the First Mechanical line, whose work precedes that of Final Mechanical. Such communication between lines takes place both verbally and in writing, sometimes in the form of a Corrective Action form -- a written document which is customarily filled out when a specific problem occurs repeatedly.

When the three individuals' comments from Final Mechanical are complete, Dolores Aguilar, a health and safety inspector of Mexican-American descent -- also a member of Team 21, reads the CSI (Customer Satisfaction Index) report to the group. This report, which comes weekly

from Teamco's customers, "grades" the company on quality, communication, and delivery. Today, as on most days, the report consists of mostly A's and some B's. The CSI report is followed by the 5S report (a health and safety report) which Dolores also reads to the group.

Following the CSI and 5S reports, it is the supervisor's turn to take up issues that she feels are important. She reiterates her expectation that all team members will be at team meetings on time unless they have a customer to attend to or there is an emergency. Rachel commends the team for their hard work and their disciplined approach. She asks if everyone is using the Total Quality Management (TQM) forms passed out at the last meeting, and Dolores suggests that they spend some time discussing TQM. Rachel explains that the leads (there are five individuals who act as leads on Team 21) are supposed to fill out the forms indicating what the most important things are that workers seem to be missing. The new forms and tracking that TQM requires mark an increase in the literate responsibilities of workers that has occurred recently with the shift to teams.

As the meeting comes to a close, final Mechanical lead Joyce Castro, a Filipina in her late forties who taught first grade for 20 years in the Philippines before coming to the United States, has some advice for her fellow workers. She tells the team that if an individual finds him- or herself with nothing to do, then he or she should come see one of the leads, who will in turn find a job that needs doing. "So you have to tell us you have nothing to do. 'Give me a job. You got a job for me?' Don't just go home and say there's nothing to do." That this is occurring comes as a surprise to Rachel, who says that the worst thing is to clock out and go home without being paid for the full eight hours. Even if it means doing paper work in her office, she says, there is always something which needs to be done, so be sure to check with either her or one of the leads before leaving Teamco for the day. She reminds people that although Team 21 is divided into five lines by customer, that technically everyone should be able to work anywhere in the Team 21 area (although in general individuals stay at one work station and do the same job rather than work at different tasks). She urges any individual who has a desire to cross-train for another line within the Team 21 domain to speak with her so that she can arrange for them to be cross-trained. She reminds them that the building supervisor "totally backs up the fact that we need to cross-train. So

if you're interested in learning something else you can cross-train within our area. Just come and see me and I can cross-train you with some other person. And everybody has to be happy about it because eventually it's gonna happen anyway. The more you learn the better off you are to the company," says Rachel.

The meeting described here is typical of the weekly meetings held by Team 21 in its uses of literacy, its opportunities for language learning, and the problem-solving that the workers are invited to participate in at Teamco. Although by company estimates over 90% of Teamco's workforce is comprised of non-native speakers of English, reading and writing in English and problem-solving are part and parcel of what workers do at Teamco everyday: they read and write meeting minutes and agendas, they receive important information from both customers as well as from internal sources about their team performance, out on the work floor they must refer to the Manufacturing Process Instructions for a wide range of different boards made by the company and they must also document defects as a means of tracking their quality and productivity, using the data they collect to keep a running tab of team performance on a weekly basis. Workers order parts from the stockroom by filling out order forms, and they have to keep track of how many and what kinds of boards are finished by their line and are then sent to shipping. Some individuals are responsible for more specialized literacy tasks such as keeping track of inventory on the computer, and entering data which will eventually be used by the team (and the various levels of management) to calculate their goals for the upcoming quarter. Clearly, a wide range of literacy skills is employed by workers at Teamco on a daily basis.

Since so many of the workers speak English as a second language, interactions occurring in English -- whether spoken or written -- present an opportunity for language learning. Toshio and Rachel's exchange (above) in which talk and gesture are co-mingled, typifies the kind of linguistic assistance and opportunities for increasing language skills that employees have access to everyday. Because the workforce represents such a variety of cultures and languages (the company estimates that collectively their employees speak over 18 languages or dialects), English -- both written and spoken -- is used by everyone as the common language of the workplace. While

workers of similar background can often be heard conversing in their native language, and many workers also write notes to themselves and one another in their native languages, they are not only able, but are obligated, to function in English according to the literacy demands, and the needs for cross-team and cross-area communication at Teamco.

In addition to being a literacy-rich, and linguistically rich environment, as indicated above, Teamco is also a place where workers must be able to problem solve on the job in a variety of ways. The accounts of Toshio, Binh and Jorge demonstrate how important identifying problems is to the team, and to the work process, but problems are not simply the subject of reports to the team; rather they constitute an integral part of the daily work life of Teamco employees. Negotiation between team members and across teams is as important as being able to discuss the accuracy of the Manufacturing Process Instructions with the engineers who design them, and sometimes matching the schemata with the actual parts and boards proves to be a challenge, as Toshio's report above illustrates. Doing what the job requires is not always as simple as it appears to be, and often making reality (boards, for example) conform to the required specifications takes an enormous amount of ingenuity as well as an informed appreciation of the problem.

However, at the same time that there is considerable effort to involve production line workers in the problem-solving processes of the workplace -- processes in which literate practices are heavily embedded -- there are also constraints on the ways in which workers can participate in such activities. This is illustrated on Team 21 by the fact that while Toshio, Binh and Jorge are sincerely appreciated for bringing problems to their supervisor's attention, they are not in positions to actually affect the changes necessary to solve the problems they perceive, but must instead rely on the leads and supervisor to consult with other lines within the factory. In this sense, although front line workers are invited to take on more responsibility, which requires them to make extended use of literate and critical thinking skills, the traditional hierarchy which shuts workers out of important loops in the factory's work processes is to a large extent maintained.

The Goal Setting Process

At mid-afternoon on a Thursday late in April, as swing shift clocks in and day shift prepares to leave, two dozen white-smocked workers gather for a Goal Review Board meeting in the Ivory Room, a square meeting and training room off the production floor, next to cubicles of buyers and marketers. Made up of production workers and supervisors representing the plant's eight functional areas, the review board has asked team representatives to share their quarterly goals for productivity and quality, to present data showing progress toward those goals, and to explain how they measure that progress, how they calculate productivity and quality.

The board members and presenters sit at three rows of tables, facing a whiteboard, an overhead projector and projection screen. Behind them and to their left are two walls of windows with miniblinds drawn, blocking the view of the parking lot and the distant hills of the Diablo Range, unusually green this spring. On the wall to their right are company posters highlighting "The Five Basic Principles Of Teamwork" and explaining "What Is An SDWT?" and "What Will SDWT's Do For US?"

Joanne Peterson, a quality engineer as well as the building's SDWT coordinator and facilitator of this meeting, has asked Mateo Bulosan, an industrial engineer, to start the meeting by explaining standard time—the time a particular work process is expected to take. Workers have been asking who sets this standard time and for what purpose, but Joanne has asked him also to talk about how it used in calculating earned hours and actual hours, and how these hours in turn are used in calculating a team's daily productivity. As he speaks and writes examples on the board, some of the workers pull calculators out of their smock pockets and check his calculations. Others jot notes, read over forms, look at the screen, then back at their notes, then confer with each other. Some appear to pay little or no attention to him and instead try to finish the overheads for the presentations they will have to make later in the meeting.

Following Mateo's explanations and examples and an extended question and answer period, Xheng Qian is called up as the first team representative to present. A high school geometry teacher in China for 14 years before immigrating to the United States in 1983, Xheng has been

working for Teamco since 1986. She started in First Mechanical, screwing brackets to boards, snapping on components, sticking on bar code labels. Currently, she is the lead in the set-up area for the SMT (surface-mount technology) lines. She and her co-workers load "feeders" or reels with IC's or with tiny resistors and capacitors that will be fed into roboticized "pick-and-place" machines, machines which place components onto printed circuit boards. Though recently recommended for promotion to swing shift supervisor for the SMT area, Xheng turned down the offer, telling the supervisor who had recommended her, the fellow who she would be replacing, that she didn't think her English was good enough. While she feels her English is fine for her current work, she's afraid that as supervisor she will have to speak with customers and doesn't feel confident enough for that. She did tell her former supervisor, however, that if he were to recommend her again when the next opportunity came up, she would be ready.

Standing at the front of the room and reading from the overheads she has prepared, Xheng summarizes her team's data collection process and their quality and productivity calculations. She is aware that the company wants teams to measure their quality in terms of parts per million (PPM)—that is, a weekly average of the number of defects or rejects per million units. In her area each loaded feeder is a unit, while in other areas each part placed on a board is a unit. Xheng knows that in an area where workers place thousands of components on boards each night, the average number of defects per week might be only 50 PPM, significantly lower than in her area, where they load only a few hundred feeders each night. She is concerned that her area will look bad if forced to use PPM as a measure of quality. This concern is heightened by a new policy linking quarterly bonuses to the team's performance against their goal, and by the new practice of displaying printouts of quality and productivity charts on the wall by the timeclock in the busy hallway between the manufacturing floor and the cafeteria. Before presenting her quality data, she argues for a different measure for her area, preferring to record the percentage of feeders loaded without rejects:

> Xheng: The quality, I think the self-feeder we cannot use the PPM. Ah, we use the percentage is better. Because ah, okay, example. [*She walks over to the whiteboard and picks up a felt pen*] Every day the average four hundred feeder we set up. If one reject, if use PPM [*She pauses to write the following on the board*]

PPM: 1/400 = X/1,000,000
X = 2500 PPM

Four hundred, four hundred feeder, one reject, we get a two thousand five hundred PPM. Very bad quality, right?

Joanne: Oh, but you don't have to worry about the number.

Xheng: [*She writes "%:" on the board and then continues*] If use percent, that's better, I thinking. Okay. Ah, one reject, four hundred feeder, right? By hundred percent. [*As she talks, she writes the following on the board*]

%: (1 — 1/400) x 100% = 99.75%

We can get ninety-nine point seven five. Very good quality. [laughs] Right? Yeah. We use percent, better. Okay. That's what I think.

Joanne tells Xheng that she need not worry about the specific number of defects, but that she and her team should instead focus on the team's quality trend. Besides, she tells Xheng, her team doesn't have much choice since the company's database is set up to record PPM as the measure of quality. And again, because that is what the company database is set up to record and print out, that is what is displayed on the quality and productivity charts—which means her team's charts, tacked up in the busiest area in the plant, appear to show quality defects at a rate five times the average for the rest of the teams.

Xheng's presentation before this goal review board and the ongoing discussions in weekly team meetings leading up to it are not the end of the goal-setting process. Once approved by the building's goal review board, the goal must be approved and signed off by the building manager, then sent for review by all of the site's SDWT coordinators and the Director of Strategic Development, the company executive overseeing team development across the site (the person in charge of, as he puts it, "grading" the team goals). Joanne's suggestion to Xheng that "you don't have to worry about the number" will prove a bit naive, for in a mid-August meeting to review goals for the first quarter of 1996, the director will tell the site coordinators that he wants teams to revise goals he marked as low:

A low goal … means the Q4 average performance was either the same or real close to what the Q1 goal was in both categories. And the number of weeks for achieving

> that was about the same. In other words, there wasn't any evidence of progress. And, there wasn't anything in the analytical section that said the reason for keeping the goal the same.

Xheng, then, has sensed correctly that a number like 2500 PPM will not play well to those reviewing the goals. It appears high compared to the numbers of other groups, and a reviewer will likely expect a team to work to bring it down the next quarter. And yet it does, after all, represent a 99.75 percent defect-free process, a difficult performance to improve upon. Joanne and Dean Kamimura, Xheng's supervisor at the time, the one who had recommended her for promotion, help Xheng and her team plan a new approach. First, they rethink what the team is counting as defects. At the same time, they devise some creative ways to enlarge her denominator a bit, thereby enabling her team to get its PPM goal down from 2500 to 500. The team's Q4 goal is submitted and approved. Over the course of the fourth quarter, the team exceeds its goal, averaging 284.6 PPM. When time comes for her team to submit its Q1-96 goals, Xheng again works with Dean. This time they write up an analysis explaining why the new goal is essentially the same as the previous quarter's goal. The final analysis reads:

> Due to the nature of PPM Calculation and infrequency of occurance [*sic*] of reported defects, and low denominator (Quantity of feeders setup), each occurance of a defect is above 3 standard deviations above the average, and exceeds UCL [upper control limit]. This creates instability in the data. Our goal will be 275 ppm ave./week (Best 10 out of 13 weeks) which is 45% lower than Q4-95 Goal.

The goals are expected to show improvement on actual performance, but with less than 10 PPM difference between Q4 performance and the Q1 goal, Dean and Xheng opt to highlight the significant difference between the two goals, rather than the difference between past performance and the new goal. The Q1 goal is approved.

The calculations Teamco workers are asked to perform at the end of each shift often involve little more than simple tallying of assemblies or components or defects, tallying which yields numbers to fill in blanks on forms handed over to supervisors. Lead workers might be required to do some multiplication and division according to the company's formulae to determine productivity and quality data. But as Xheng's foray into the Teamco world of mandatory goal-setting suggests,

"basic" numerate practices in this workplace go well beyond simple tallying and filling in blanks; they include an analysis of the settings in which the calculations are used—not just "used" but embedded, inextricably linked with particular literate practices within the company.[6] Xheng's situation suggests that workers need to be able not only to collect data and plug it into formulae to calculate earned hours and actual hours and parts per million, but to know what a team's numbers mean in relation to those of other teams, and to know how these numbers will be interpreted, by whom and toward what end. Even further, Xheng shows the workers' need to know alternative formulae, to understand various uses of calculations, to understand how to present data orally and in writing and how to argue with numbers. Xheng and Dean, in preparing the Q1 goal, also demonstrate the importance of being able to work with the simplified, standardized form and the system of measure imposed on them by the company, and still accurately and fairly represent a complex work process. This has gained particular importance since team bonuses are based on performance against a company-approved goal, and the person with the official stamp of approval expects "evidence of progress" from quarter to quarter.

Discussion

A few things deserve further comment. First, a caution against some of the popular notions about teams and the changing workplace. There is much vague, romantic talk about workers "thinking for a living" and being "empowered" through teams. And in some ways we have contributed to that talk by choosing in this article to focus on Team 21 and Xheng. We should temper that a bit by noting that we also sat through some painfully silent meetings, meetings the team members described as a waste of time. While it's true that Teamco offers opportunities for some workers to become involved in work processes in ways we don't find in the more traditionally organized workplace, at the same time this new workplace is a stressful one, putting more and more demands on the workers -- literate and otherwise -- while keeping firmly intact its

[6] In fact, these numerate and literate practices are part of the fabric of the data-obsessed culture of the company, a culture whose lore has the company founder, a Ph.D. in Applied Mathematics, implementing statistical process controls before it was the industry fashion and demanding data-based accountability from division managers in ways that, as the lore has it, pitted building against building in a drive for top marks in quality—a drive which, as we mentioned earlier, has netted the company a number of awards for quality.

reputation for being a low-paying company. In this sense, as we pointed out earlier, workers are invited to take on more responsibilities, many of which are embedded in literate practices, without being offered any real shift in the ability to shape their work environment. In fact, it is our sense that the workers' new literate responsibilities at Teamco has increased both their accountability and the degree to which their work is monitored by managers and supervisors. In sum, the invitation to 'think critically' and be 'empowered' has been accompanied by a degree of micro-management that many workers find stifling, if not also antithetical to the team process.

Secondly, Toshio's finding that workers were unable to place a component on the board as instructed in the MPI helps highlight something we have found often at both workplaces over the three years of this study: In a text-saturated workplace such as Teamco, where frequent and unexpected change is the norm, reality on paper and reality on the factory floor don't always match. For example, a process outlined in the MPI is at times incompatible with the physical properties of the components or the way a board is configured. Workers trying to reconcile how things are supposed to be with how they actually are on the floor are left to negotiate successful work practices in creative ways. Contrary to the popular discourse, which presumes that workers currently don't "think for a living," we have observed both critical and creative thinking in the more traditionally organized workplace as well as at Teamco.

Finally, the popular discourse about work and workers tends to grossly underestimate workers' oral and literate competencies and problem-solving abilities. The consultant's lament which opened the article echoes federal reports warning that "demographic trends, technological change, and increased international competition already are creating shortages of skilled workers and an excess of unskilled workers, problems that are likely to worsen in the years ahead" (*Investing*, 1989, p. vii). The demographic trends this report alludes to are the increasing numbers of women, people of color, immigrants and elderly European Americans in the workforce. According to Former Secretary of Labor Ann McLaughlin:

> A growing share of our new workers will come from groups where human resource investments have been historically deficient—minorities, women, and immigrants. Employers will increasingly have to reach into the ranks of the less

> advantaged to obtain their entry-level work force, frequently those with deficient basic skills (Quoted in *The Bottom Line*, 1988, p. ii)

Joining the chorus is Bill Wiggenhorn, Motorola's vice president and director of education and training. He speaks of production workers who "lack basic math skills ... cannot comprehend English ... do not read above the first grade level ... (and) cannot think—do problem solving" (quoted in Marshall & Tucker, 1992, p. 98).

Contrary to these characterizations, however, we have observed workers of a wide range of ages and from varied cultural, educational, technical, and professional backgrounds draw on multiple forms of representation—talk, mimings, drawings, demonstrations, models, mathematical calculations, written documents—to get work done, quite often on schedule and with a high degree of quality. That is not to say that we have observed no problems on the production line, no conflicts, no mistakes, no miscommunication. We have seen blunders and conflicts of all kinds. Nonetheless, we have to object to the indiscriminate characterizations of workers reflected in much research on the workplace and in much of the popular discourse about work and workers' skills and knowledge.

What does any of this have to say for schools? At a time when some school-to-work initiatives focus their efforts on constructing industry skills standards and linking them to school curricula, it might be tempting to extract from Xheng's foray into the Teamco world of goal-setting, for instance, a few tidy little student learning objectives: "Given a formula for calculating quality and productivity, the student will be able to gather data, plug appropriate numbers into the formula, and record the products on a spreadsheet." Or, "Given a series of data entries, the team will identify trends in that data and then plan a course of action to improve those trends." But we would hope Xheng's and Team 21's experiences would help us see literacy and numeracy not as discrete skills but rather as embedded in the particular practices of the workplace, influenced by personal, communal and organizational histories.

We feel it is critical to think more carefully about how such literacy practices are embedded in the workplace, and to make more of an effort to understand workers' skills and knowledge -- to resist the assumptions so frequently made about people's educational and professional histories.

The multiple demands of workplaces such as Teamco—high-tech, multi-ethnic workplaces in rapidly shifting markets—do not call for a static set of "basic" skills, but rather for ways of negotiating, of finding common ground. As educators, we must look beyond a skills-based, building-block approach to curriculum design, and keep ever present in our minds the knowledge that literacy practices are part and parcel of social networks, and that such practices traverse the complex and sometimes contradictory agendas of managers and workers, just as they do teachers and students in schools. More important than any static set of skills are schools and workplaces which honor negotiating, which nurture multiple perspectives and accommodate multiple forms of representation—schools and workplaces which grant students and workers the authority to draw on their own experience, to add their perspectives to decision-making processes, even as they (or in order that they might) expand those perspectives and that experience.

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